Demonstration of a Hybrid Space Architecture during RIMPAC 2020

SmallSat 2021 Conference, Virtual Event

Charlene Jacka
Air Force Research Laboratory
On Behalf of the MSMU PA Participants

Agenda

- INTRODUCTION
- EXPERIMENT DESCRIPTION
- EXPERIMENTS OBJECTIVES & AGGREGATED RESULTS
- CONCLUSIONS

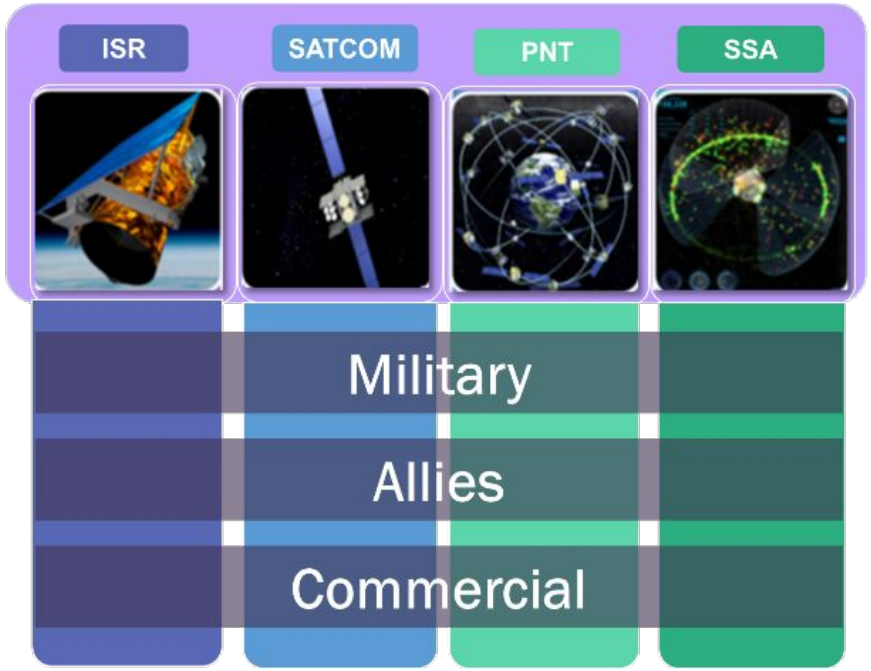
Hybrid Space Architecture (HSA)

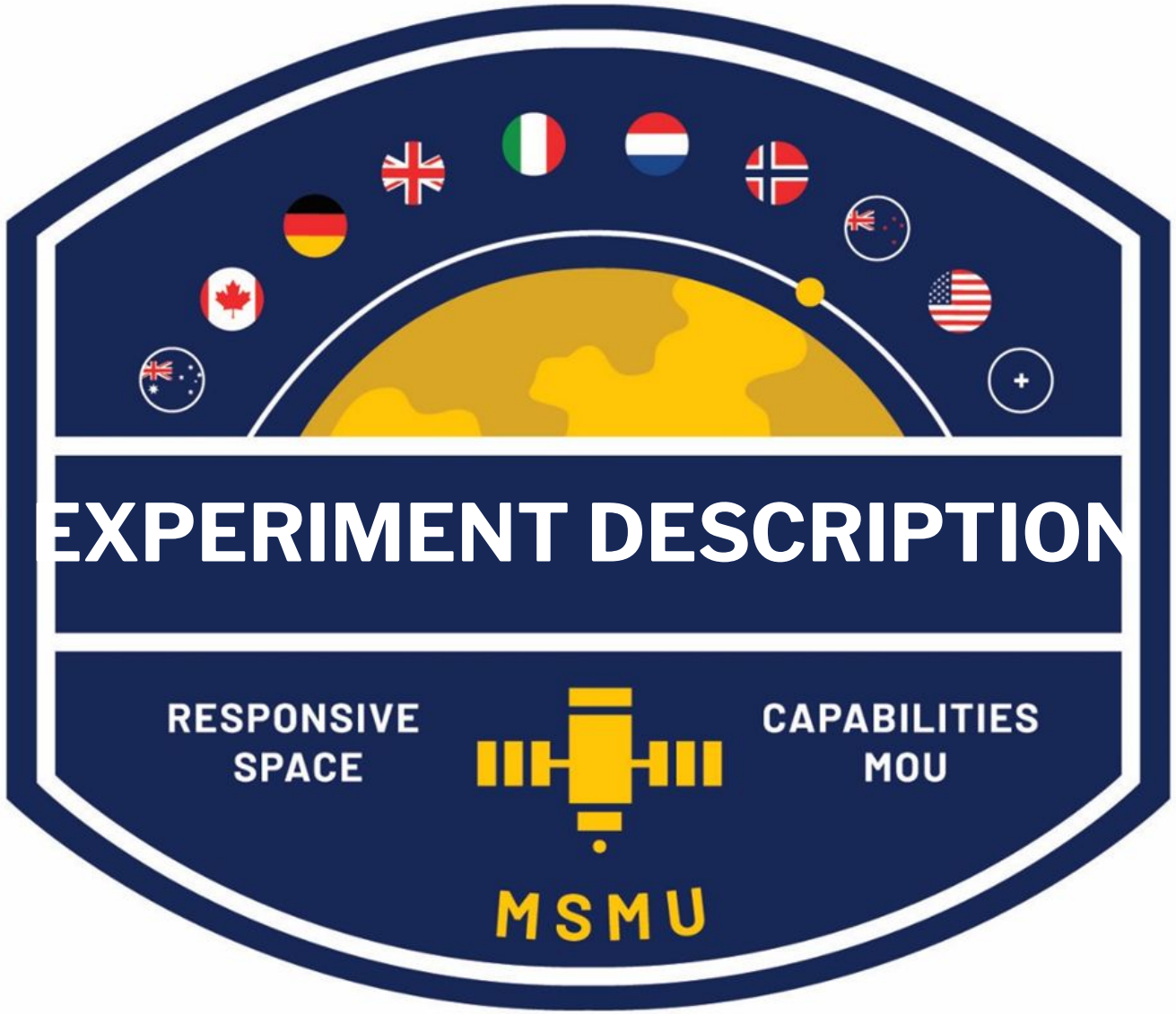
Constellation of government-owned (military and civil), allied and commercial satellites

- equipped with different phenomenologies
- capable of collecting ISR data needed to produce the Common Intelligence Picture (CIP) that assists the Warfighters' decision-making process.

Iterative experimental method

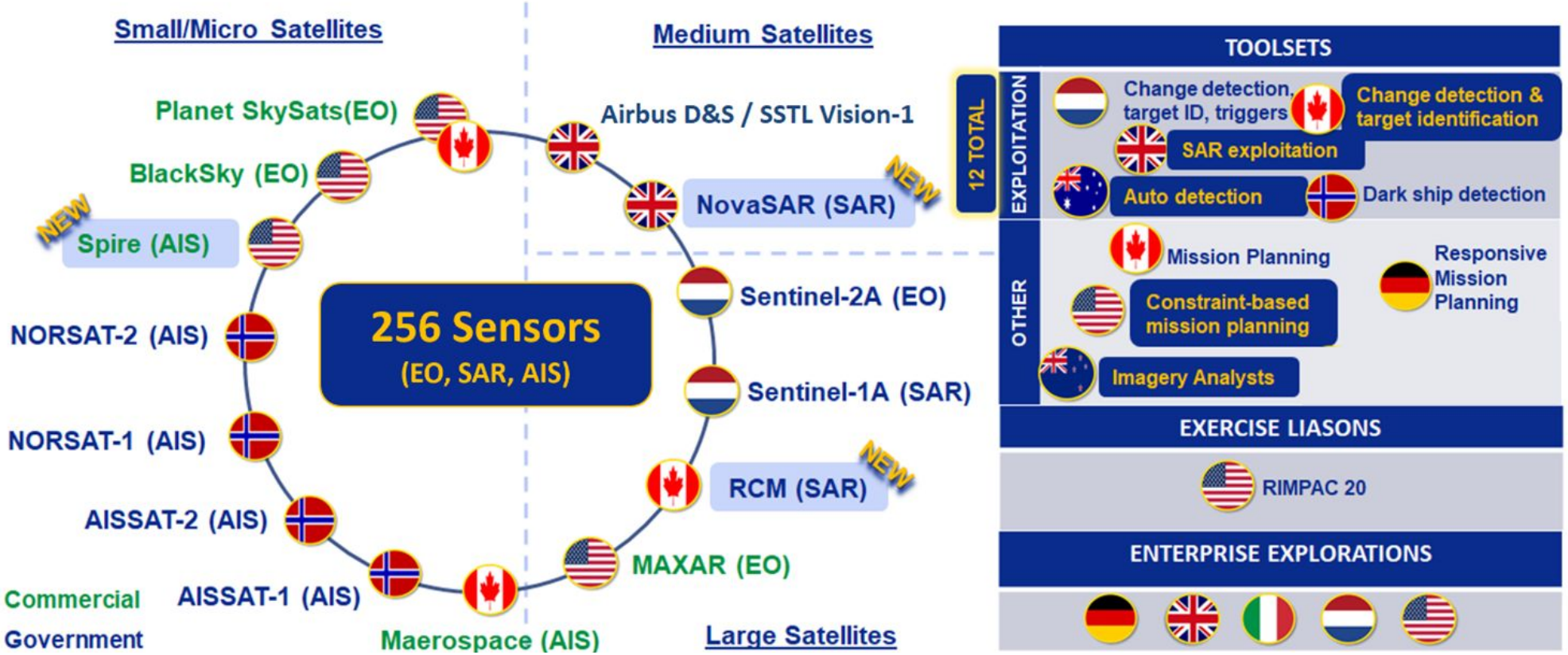
- Conduct enterprise explorations, i.e. analyses efforts to characterize the HSA capability.
- Conduct an S&T demonstration to test capabilities and evaluate challenges.
- Demonstrate best performing capabilities to military users and gather feedback.
- Evaluate utility based on performance and feedback stemming from demonstrations.





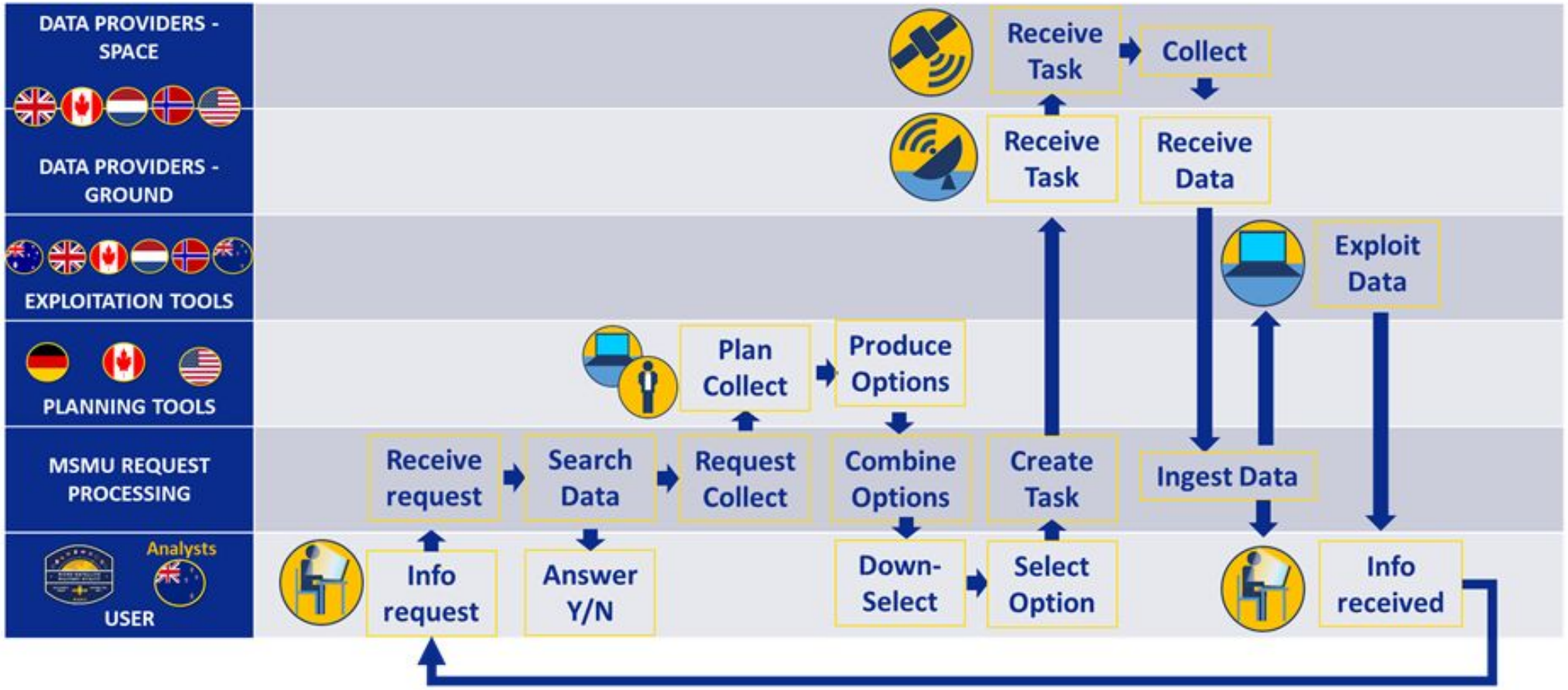
MSMU Contributions for RIMPAC 2020

- MSMU used data providers, exploitation tools, planning tools, and enterprise explorations as organized by the contributing nations to the RIMPAC 2020 experiment from experience and document lessons learned.



TCPED

Simplified execution process as based on a modified version of the Intelligence Requirements Management and Collection Management (IRM&CM) process used by NATO

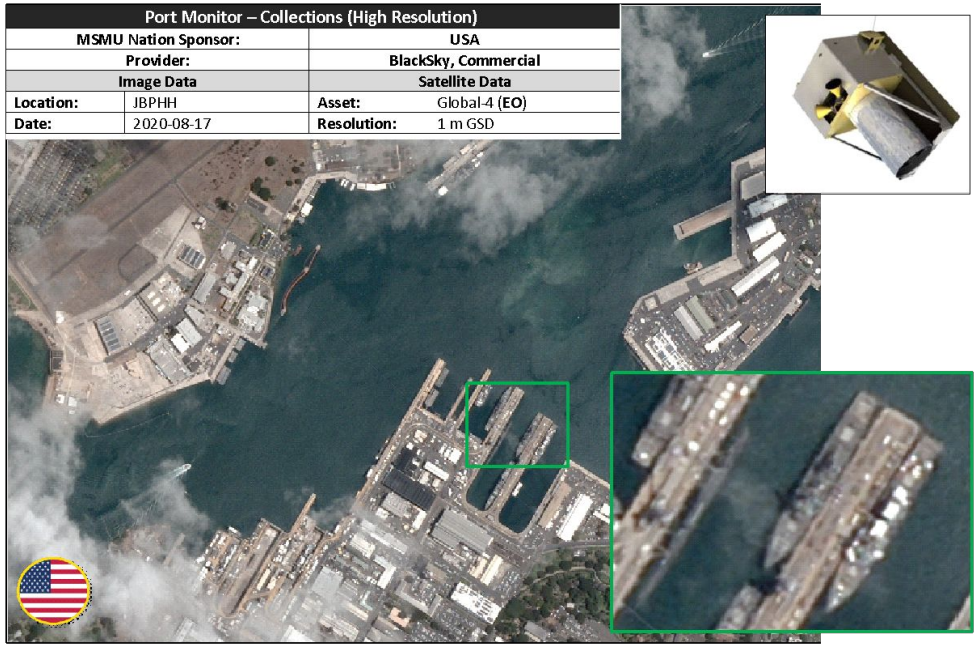


Objective 1

Static Target Point/Pattern of Life Vignette **FULLY REALIZED**

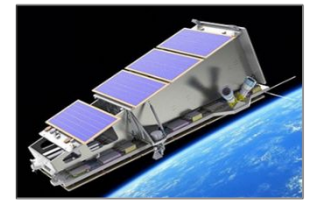
- Understand the value and capability of MSMU HSA multi-temporal and multi-phenomenology (EO/SAR/AIS) observations and exploitation for automated monitoring of military activities in a defined static target area, including pattern of life determination and anomaly detection and inspection.

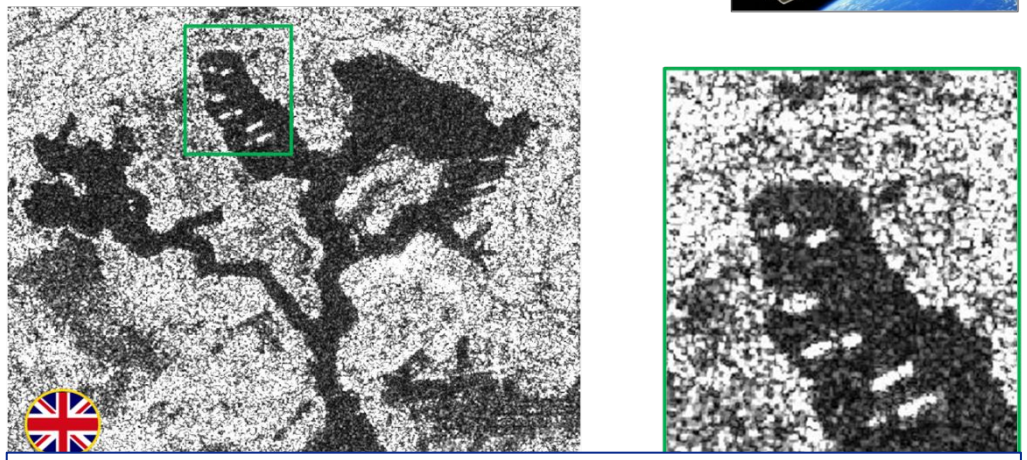
Port Monitor – Collections (High Resolution)			
MSMU Nation Sponsor:		USA	
Provider:		BlackSky, Commercial	
Image Data		Satellite Data	
Location:	JBPHH	Asset:	Global-4 (EO)
Date:	2020-08-17	Resolution:	1 m GSD



Commercial satellite (BlackSky, microsat) - Port Monitoring (EO)

Port Monitor – Collections (Low Resolution)			
MSMU Nation Sponsor:		GBR	
Provider:		SSTL, Government	
Image Data		Satellite Data	
Location:	JBPHH	Asset:	NovaSAR-1 (SAR)
Date:	2020-08-18	Resolution:	6m, 20m, 30m



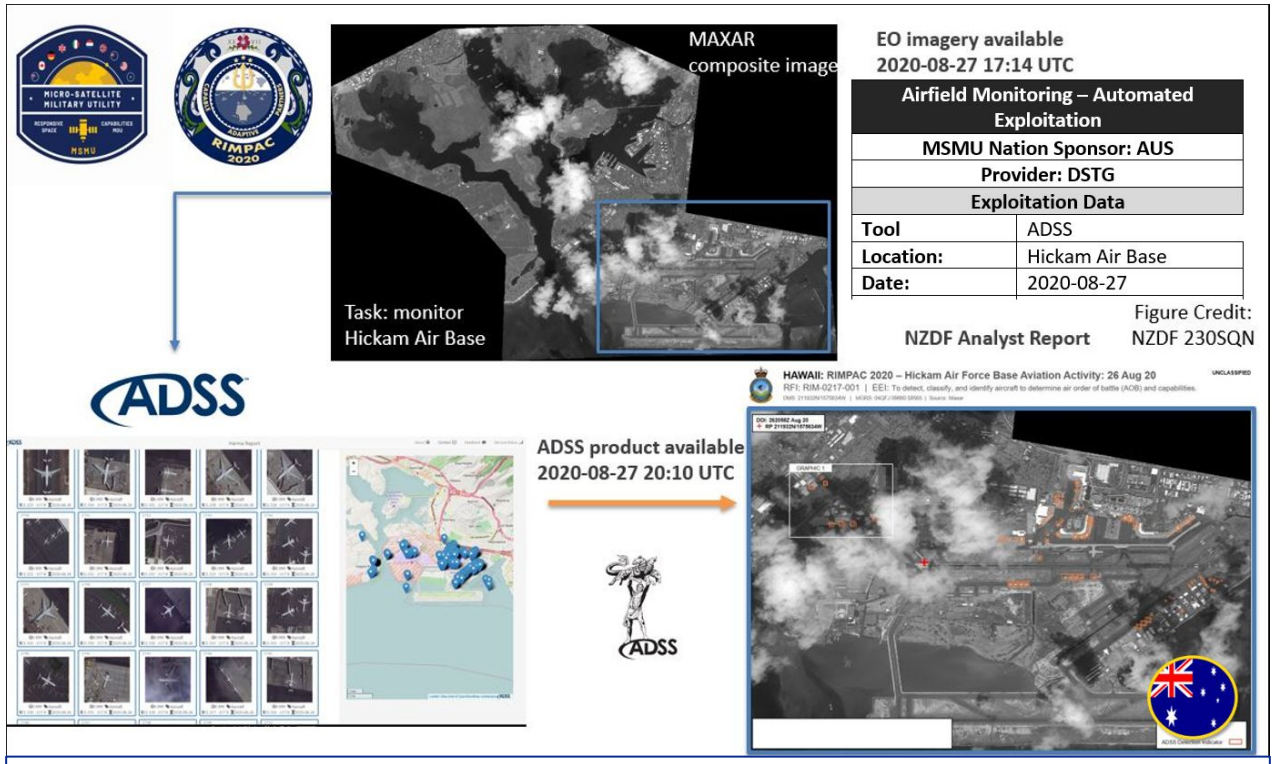


Commercial satellite (NovaSAR-1, medium class satellite) - Port Monitoring (SAR). Image credits: SSTL

Objective 2

Monitor Force Buildup/Pattern of Life Vignette **REALIZED**

- Demonstrate how automated site monitoring tools and deep learning can be adapted for detection and classification of aircraft and monitoring airfield activities.



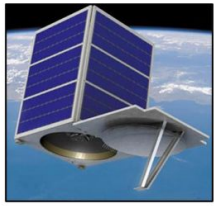
Military Analysts (DSTG) data for Airfield Monitoring

Objective 3

Battle Damage Assessment Vignette
NOT REALIZED

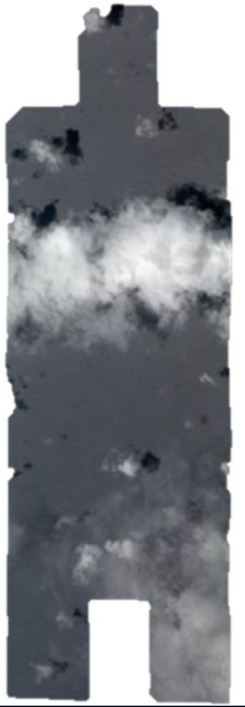
- Examine the capability and utility of MSMU HSA to support a battle damage assessment of a vessel with low latency using high frequency multiple EO, SAR, and AIS collections.

SINKEX – Collections (High Resolution)	
MSMU PA Sponsor: CAN	
Provider: Planet, Commercial	
Satellite Data	
Asset:	SkySat (EO)
Resolution:	< 1.0 m GSD



SkySat - 29Aug @ 1128AM UCT-

SkySat - 29Aug @ 0156PM UCT-



Commercial satellite (Planet, microsat) picture for BDA (EO asset)

Objective 4

Rendezvous/Dynamic Bounded Target Vignette **PARTIALLY REALIZED**

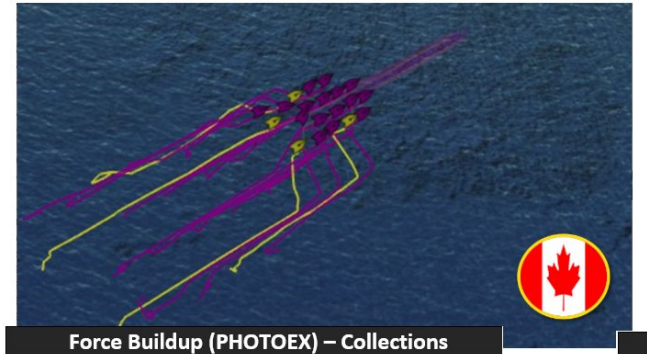
- Understand the value of using AIS data for real-time anomaly detection, including automated detection of close interactions, in order to cue collection by high resolution imaging capabilities to determine activity.

Objective 5

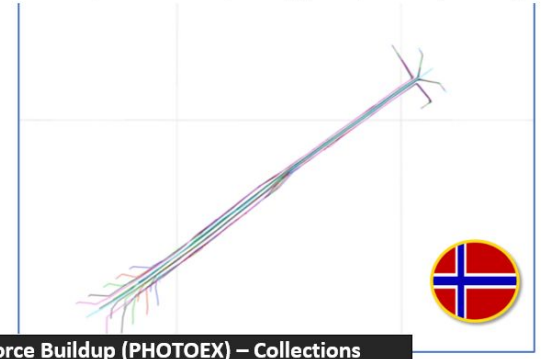
Dynamic Trajectory Target Vignette
REALIZED

- Understand the value of multi-int pervasive collection to aid in anomaly detection.

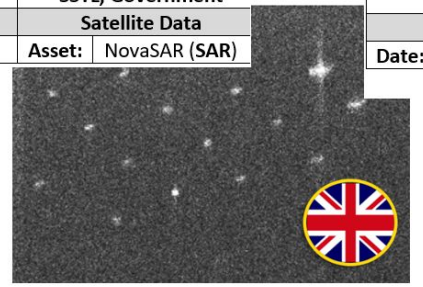
Force Buildup (PHOTOEX) – Collections			
MSMU Nation Sponsor:		CAN	
Provider:		Maerospace, Commercial	
Image Data		Satellite Data	
Date:	2020-08-21	Type:	AIS



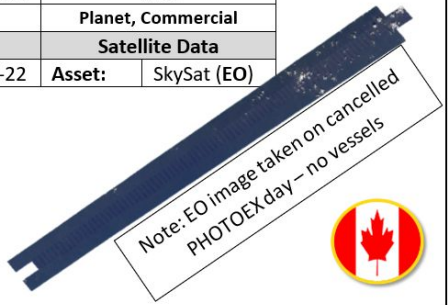
Force Buildup (PHOTOEX) – Collections			
MSMU Nation Sponsor:		NOR	
Provider:		FFI, Government	
Image Data		Satellite Data	
Date:	2020-08-21	Asset(s):	NORAIS, AISSAT (**AIS**)



Force Buildup (PHOTOEX) – Collections			
MSMU Nation Sponsor:		GBR	
Provider:		SSTL, Government	
Image Data		Satellite Data	
Date:	2020-08-21	Asset:	NovaSAR (**SAR**)



Force Buildup (PHOTOEX) – Collections			
MSMU Nation Sponsor:		CAN	
Provider:		Planet, Commercial	
Image Data		Satellite Data	
Date:	2020-08-22	Asset:	SkySat (**EO**)



Images collected for Dynamic Trajectory Tracking. NovaSAR image credits: SSTL

Objective 6

Dynamic Trajectory Target/Track Custody of Fleet Vignette **N/A**

- Examine the ability of the HSA to track and maintain custody of fleet of ships while in transit from California to Hawaii.

Event did not occur due to down-scoping as a result of COVID-19 impacts.

Objective 7

Detect and Track uncooperative Dark Vessel Vignette **PARTIALLY REALIZED**

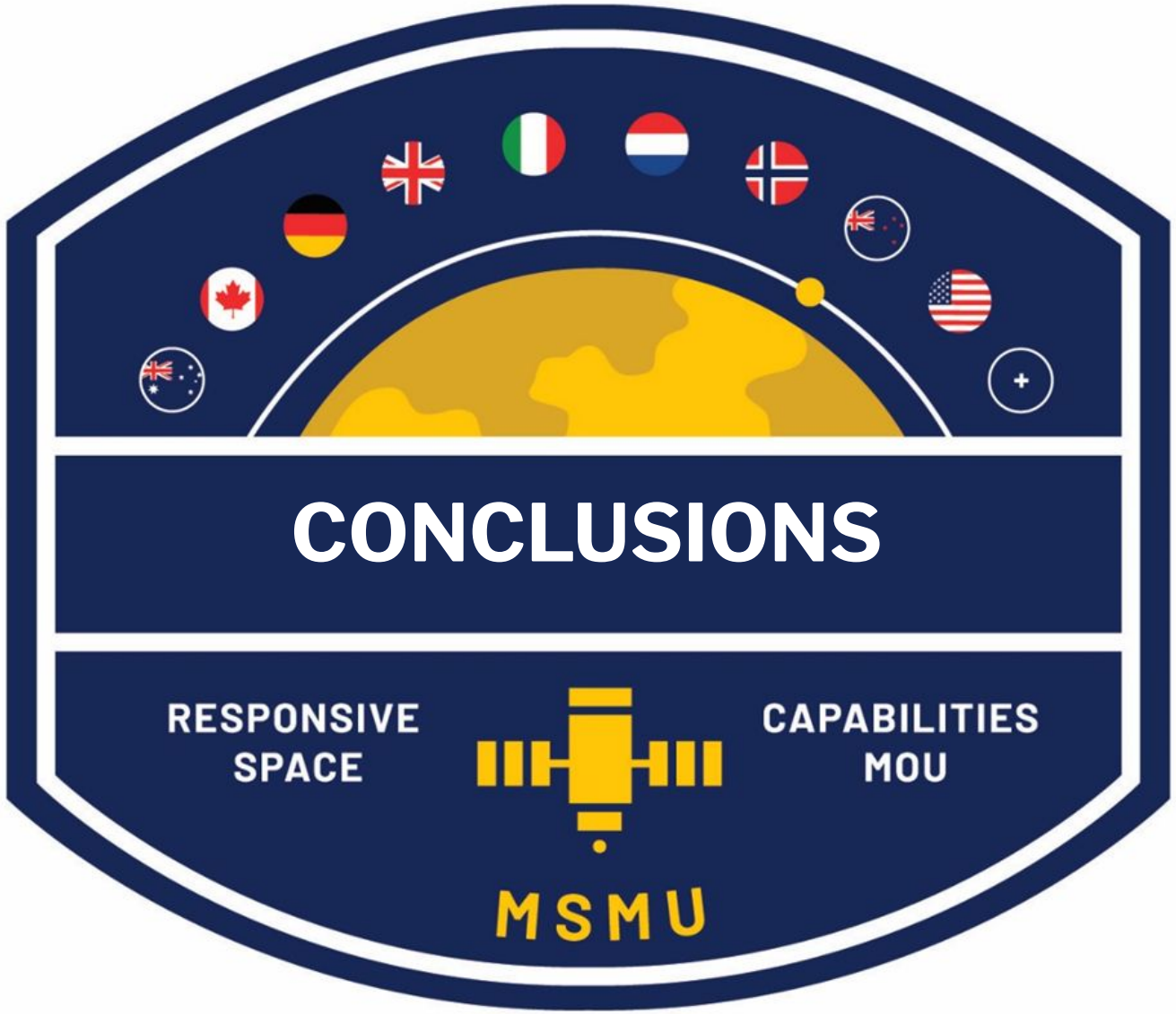
- Understand the value of systematic multi-temporal and multi-phenomenology observations and exploitation for automated detection of dark ships and the potential tipping and cross cueing of dynamic collection assets to identify and track the target.

Objective 8

TCPED Process and Metrics **REALIZED**

- Examine the RFI/RFC and TCPED processes associated with the fundamental MSMU core processes as they relate to and support Analysis Objectives 1-7.

There were some challenges experienced with regards to data discovery due to the large amount of data collected during the exercise. Manual processes significantly influenced the timeliness of metrics captured. Semi-automated mission planning significantly reduced the time to plan collections.



Conclusions

- The HSA was designed to accommodate a large sensor diversity amongst participating nations assets, thereby maximizing their utility.
- MSMU's HSA's research continues to improve capability development and increase partner nations interoperability.
- The level of interoperability accomplished via the MSMU-constructed HSA during Exercise RIMPAC 2020 was adequate to facilitate fully remote support despite COVID-19 impacts.
- This year's results, including analyst tipping by fully automated exploitation results, demonstrates the potential impact of solutions that enhance the utility of the HSA, ultimately to address the warfighters need to vastly increase ISR sources using both commercial and government assets across allied nations.